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(56) Documents Cited
GB 2287858 A GB 2240696 A EP 0599559 A1
EP 0504122 A2 WO 96/05709 A1 WO 91/19403 A1
US 5422933 A

(58) Field of Search
UK CL (Edition N) H4L LDSH
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ONLINE: WPI

(54) Handover with Variable Thresholds

(57) A handover management method for a cellular radio network of the type in which link quality is monitored (301) and compared against selected thresholds (303) to determine when and to which neighbouring cell handover should occur including threshold adjustment means (304) for dynamically changing the thresholds during the progress of a call.

GB 2 313 740 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

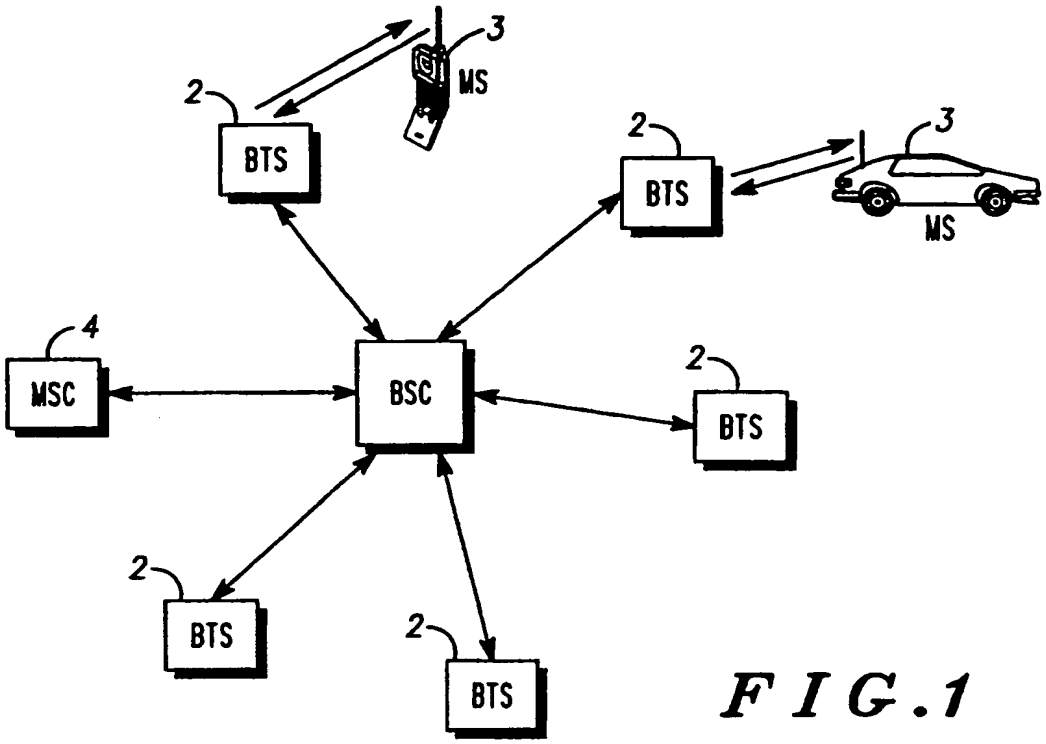
3
MS
2
BTS
2
BTS
3
MS
4
MSC
BSC
2
BTS
2
BTS
2
BTS

FIG.1

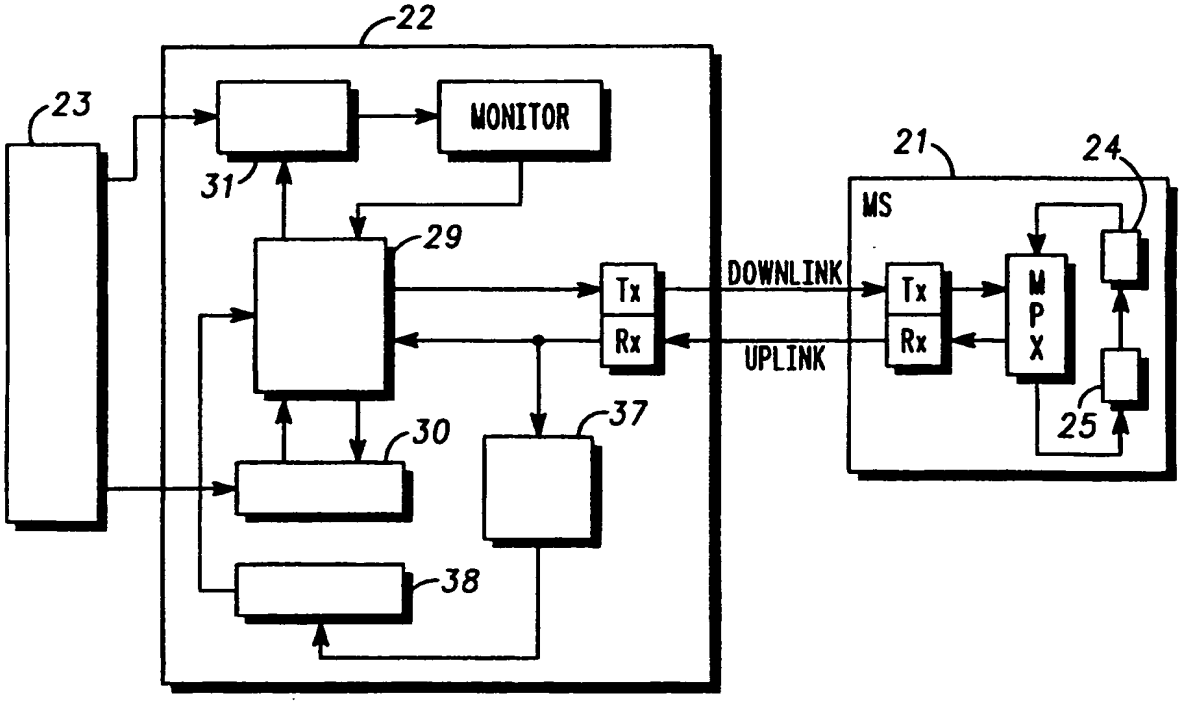
22
23
MONITOR
31
29
Tx
Rx
30
37
38
DOWNLINK
UPLINK
21
MS
24
Tx
Rx
M
P
X
25

FIG.2

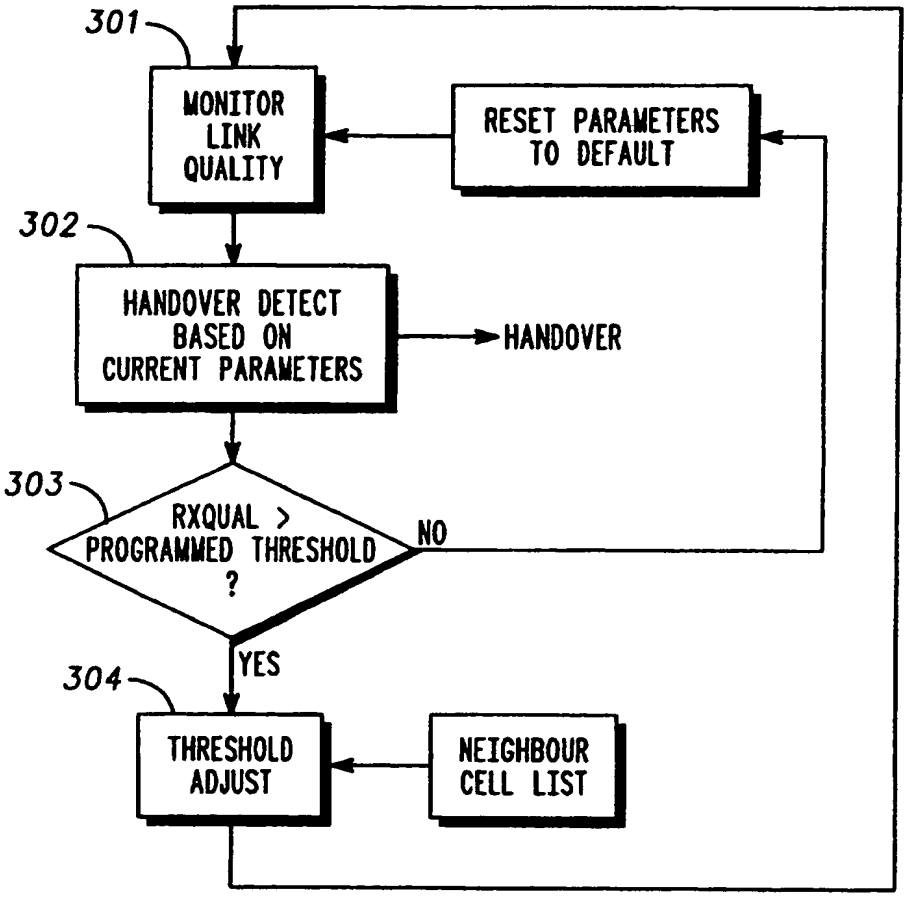
301
MONITOR LINK QUALITY
RESET PARAMETERS TO DEFAULT
302
HANDOVER DETECT BASED ON CURRENT PARAMETERS
HANDOVER
303
RXQUAL > PROGRAMMED THRESHOLD ?
NO
YES
304
THRESHOLD ADJUST
NEIGHBOUR CELL LIST

FIG. 3

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HANDOVER MANAGEMENT SYSTEM FOR CELLULAR NETWORK

Field of the Invention

This invention relates generally to cellular radio communication systems and more particularly to mechanisms for managing the handover of communication from one cell to another in such systems.

Background of the Invention

When the traffic density in a multicellular radio network is relatively low the main parameter determining when and how handover occurs is the strength of the signal in the current (serving) cell compared with the strength of signal attainable in neighbour cells. Such a system is said to be RF coverage limited.

However as traffic demands increase, it becomes necessary to make more effective use of the limited available frequency bandwidth. In practice this implies more intensive reuse of available channel frequencies in a given geographical area, increasing the potential for interference. Systems thus become increasingly interference limited, and the management of handover becomes considerably more complex.

The general principles governing the management of handover in a typical current cellular network operating under the GSM (Global System for Mobile Communications) are described in the publication entitled "European digital cellular communications system (Phase 2): Radio subsystem link control," GSM 05.08 version 4.9.0, dated 15 April 1994, by the European Telecommunications Standards Institute (ETSI).

When a system becomes interference limited, failure of a link and the loss of a call (dropped call) can be caused not only by reduced signal strength but also by interference itself, even where the signal would otherwise be adequate. Techniques have been developed for measuring link performance in terms of a number of parameters rather than a single parameter, such as signal strength, for minimising the risk of failure following handover. However it has been found that the use of such techniques in certain circumstances can affect system capacity adversely.

There is accordingly a need to provide a handover management system for a cellular network which provides improved control of handover while minimising the level of dropped calls.

Summary of the Invention

According to one aspect of the invention there is provided a handover management system for a cellular radio network including monitor means for monitoring the performance of an operational link and potential alternative links against test parameters and handover processing means responsive to said monitor means and to stored parameter thresholds to select an alternative link from a number of candidate links for handover of a call in the event that the monitored performance of said operational link falls below a given level, characterised by threshold adjustment means responsive to said monitor means and said handover processing means to modify one or more of said stored parameter thresholds during the occupancy of said operational link by a call.

According to a second aspect of the invention there is provided a method for managing handover in a cellular network system of the type in which the performance of an

operational link and potential alternative links is continuously monitored against selected parameters and handover decisions are made according to the margin between such parameters and programmable thresholds, the method including the step of dynamically varying one or more of said thresholds during the occupancy of said operational link by a call.

Normally the threshold adjustment means will operate to reduce the thresholds of the various parameters in order to enable a transfer from one cell to another to be made more easily. Such a reduction will be made to the threshold levels for specified neighbour cells.

In a preferred embodiment of the invention, a threshold register is dedicated to each call during its occupancy of the operational link so as to maintain dynamically adjusted parameters against which the performance of the link can be assessed.

In order that the invention may be well understood a preferred embodiment thereof will now be described with reference to the accompanying drawings.

Brief Description of the Drawings

FIG.1 is a block diagram of a typical multicellular sub system.

FIG.2 illustrates a multicellular sub system embodying the present invention.

FIG.3 is a flow diagram illustrating the process performed by the system of FIG.2.

Detailed Description of a Preferred Embodiment

Referring first to FIG.1 there is shown a part of a typical cellular network, referred to as a Base Subsystem

(BSS), operating under the GSM (Global System for Mobile Communications) protocol. A base station controller (1) is connected to a number of base transceiver stations (2) each of which includes the transmitting and receiving equipment necessary to communicate with one or more mobile stations (3) within its service area. As is well known the base transceiver stations are arranged geographically to provide a pattern of overlapping cells such that a mobile station moving within the area served by the base station can maintain communication by handing over transmission from a current (serving cell) to a neighbour cell when the performance of the current link falls below certain specified standards. The base station controller (1) is connected to a mobile services switching centre (4) to permit transfers to other parts of the network when the mobile station moves out of the service area of the current subsystem. The switching centre (4) also performs the line switching and other operations necessary to connect a mobile station with other stations, fixed or mobile, in remote service areas, for example when a mobile station served by one of the base transceivers (2) is called by, or wishes to call, a subscriber in a different part of the country. Where one mobile station within the service area of the subsystem wishes to call another mobile also within that service area, the base station controller (1) in conjunction with the switching centre (4) will normally perform the necessary processing.

The purpose of the base station controller (1) is to provide a dedicated channel of communication between a mobile station (3) and the switching centre (4) throughout a call despite movement of the mobile station. When a mobile station is idle, i.e. not making or receiving a call, it monitors a paging channel associated with the base station controller (1) for instructions by which it may be activated. On activation it is allocated a dedicated channel by the base station controller (1) and from that

point on performs measurements of the allocated channel and of channels allocated to neighbouring cells to provide information necessary for the decision to trigger transfer of communication at the right moment and towards the right cell when the quality of the current link falls below selected standards. Performance is measured by monitoring a number of parameters including signal level and error rate. The transfer process is managed by a processor which uses a handover algorithm to evaluate measurements taken at the mobile station and at the serving transceiver station against certain parameter thresholds to produce a preferred list of target cells for handover and to select a cell from such list when handover takes place.

FIG.2 shows a base subsystem embodying the present invention. For the purposes of this description a single mobile system (21) is shown in communication over a channel which provides an up link and a down link to a base transceiver (22) which is served together with a number of other base transceivers by a base station controller (23). Conventionally the mobile station includes a monitoring facility (24) capable of measuring various link parameters not only for the link currently in operation but also for potential links to a number of neighbouring cells listed in a register (25) which has already been loaded over the down link from a database in the base station controller (23). The mobile station includes a multiplexer (26) which permits the monitored data to be transferred while at the same time maintaining the voice or data connection. The base transceiver station (22) is similarly provided with monitoring means (27) to enable separate measurements of the various parameters to be made at the transceiver location.

As before the base station subsystem (BSS) includes a handover processor (29) which operates in conjunction with a default threshold register (30) and a resource manager

(31) to make decisions as to suitable candidates for transfer and the timing of handover in response to measurements transferred from the monitoring means (27) and the mobile station (21) respectively over data links (32) and(33). The list of suitable candidates for transfer is supplied by the resource manager over a line (35) under the control of the handover processor (29) and the decision to transfer is applied over line (36) to provide an appropriate instruction to the mobile station (21).

The data in the resource manager (31) are typically initialised from corresponding data held in the BSC (23).

In a typical known system the handover processor operates in conjunction with the resource manager and the default threshold register in accordance with an algorithm such as that described in the ETSI publication GSM 05.08 referred to above to evaluate link performance against certain pre-set thresholds. In accordance with the present invention however there is further provided a threshold processor (37) which takes the default thresholds and dynamically varies them during a call to provide one or more alternative thresholds which can be applied to the handover processor for that particular call to determine whether a transfer can be more easily made. The alternative thesholds are maintained in a current threshold register (38) which is dedicated to a particular call. This provides a more flexible means of determining the thresholds applied to the handover processor and enables candidates to be selected for transfer which might otherwise have been overlooked, thereby permitting more effective use of the frequency spectrum.

It will be appreciated that although the threshold processor (37) and the threshold register (38) are shown as separate components in FIG.2 they may conveniently be

realised as modules performed by the processing facilities already provided in the subsystem.

FIG.3 is a flow diagram illustrating the procedure performed in the embodiment described above with reference to FIG.2. The start of the process is at step 301 where the quality of the down link is monitored as described above. Other measurements such as the quality of the up link may also be taken into account at this stage. At step 302 the handover decision process is started using parameter thresholds currently set. Initially these will be the default parameter thresholds stored in register 30. At step 303 a test is made to determine whether the quality of the up link signal, while sufficient to maintain the current call, is of a level to indicate that a link to an alternative base station might provide better service either at the present time or in the future. The parameter used here is the parameter rxqual as defined in the ETSI document GSM 05.08 identified above which is high when the link is deteriorating and low when it remains good. Thus the test made at step 303 determines whether rxqual exceeds a selected level. If it does not, i.e. the link remains good, the test parameter thresholds are re-set to their default values. However if rxqual exceeds the selected threshold the threshold processor 307 proceeds at step 304 dynamically to reduce the thresholds for specified neighbour cells. Thresholds which may be reduced are 1) the handover signal strength margin 2) the averaging period over which monitored signal strengths are calculated (hrequave in document GSM 05.08). Different amounts of reduction may be applied according to the amount by which rxqual differs from the selected threshold. Further, other parameters, such as the current traffic density, may be monitored at step 303 to provide input to the threshold processing operation.

The neighbour cells for which thresholds are dynamically reduced are selected from a database maintained by the resource manager (31). However as the process continues other cells may be identified as candidates for transfer, and these may be incorporated into the neighbour list as the call proceeds, while others may be deleted.

As a result of step 304 new parameter thresholds are applied at step 301 and the detection process at 302 operates on the modified thresholds. If as a result of this detection process a candidate for transfer is identified a decision is then made whether or not to institute a transfer in conjunction with the resource manager (31) the timing of such transfer being dependent on the availability of the target cell.

Although the dynamic threshold adjustment process has been described above as involving only the reduction of the selected thresholds circumstances could arise in which it may be advantageous to raise a particular threshold while simultaneously reducing others. Further, while the processing operations have been described in FIG.2 as taking place largely in the base transceiver station (22) it will be appreciated that if sufficient function is available in the other major units of the subsystem such as the mobile stations and the base station controller (23) parts of the processing, such as pre-processing of the signal quality measurements, could be delegated to these other units.

What is claimed is:

CLAIMS

1. A handover management system for a cellular radio network including monitor means (24,27) for monitoring the performance of an operational link and potential alternative links against test parameters, and handover processing means (29) responsive to said monitor means and to stored parameter thresholds to select an alternative link from a number of candidate links for handover of a call in the event that the monitored performance of said operational link falls below a given level, characterised by threshold adjustment means (37) responsive to said monitor means to modify one or more of said stored parameter thresholds during the occupancy of said operational link by a call.

2. A system as claimed in claim 1 including a current threshold register (38) associated with each call during its occupancy of the operational link and settable under the control of said threshold adjustment means to maintain dynamically adjusted parameters against which said performance is determined for the associated call.

3. A system as claimed in claim 1 or claim 2 in which said threshold adjustment means is responsive to said monitor means to reduce the signal strength handover margin when said monitored performance falls below a given level.

4. A system as claimed in any preceding claim in which said threshold adjustment means is responsive to said monitor means to modify the averaging time over which

monitored signal strengths are calculated when said monitored performance falls below a given level.

5. A system as claimed in any preceding claim in which said threshold adjustment means is responsive to link quality as indicated by error level to determine said monitored performance.

6. A system as claimed in any preceding claim in which said threshold adjustment means is responsive to signal traffic density to determine said monitored performance.

7. A threshold management system substantially as described with reference to FIG.2 and FIG.3 of the accompanying drawings.

8. A method for managing handover in a cellular network system of the type in which the performance of an operational link and potential alternative links is continuously monitored against selected parameters and handover decisions are made according to the margin between such parameters and programmable thresholds, the method including the step of dynamically varying one or more of said thresholds during the occupancy of said operational link by a call.

9. A method as claimed in claim 8, including maintaining a register of dynamically varied thresholds during the occupancy by said call of a current operational link.

10. A method as claimed in claim 8 or claim 9, including reducing the signal strength handover margin associated with said link if said performance falls below a given level.

11. A method as claimed in any preceding claim, including modifying the averaging time over which monitored signal

strengths are calculated when said performance falls below a given level.

12. A method as claimed in any preceding claim, in which the quality of said operational link as indicated by error level is monitored to determine said performance.

13. A method as claimed in any preceding claim, in which signal traffic density is monitored to determine said performance.

14. A method for managing handover in a cellular network system, substantially as described with reference to Figures 2 and 3 of the accompanying drawings.

The Patent Office

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Application No: GB 9611305.5 **Examiner:** Nigel Hall
Claims searched: all **Date of search:** 25 July 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4L (LDSH)

Int Cl (Ed.6): H04Q 7/38

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X,Y	GB 2287858 A	(MOTOROLA) See abstract	1,8
X,Y	GB 2240696 A	(NEC) See claim 4	1,2,8.9
X,Y	EP 0599559 A1	(NEC) See col.4, lines 1-6	1,6,8,13
X,Y	EP 0504122 A2	(ERICSSON) See col.3, lines15-17	1,8
X,Y	WO 96/05709 A1	(PACIFIC) See pages 35-37	1,2,8,9
X,Y	US 5422933	(BARNETT) See col.7 line 59-col.8 line	1,8
Y	WO 91/19403 A1	(B.T.) See whole document	4,11

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.